DOI 10.15826/rjcst.2017.1.008 УДК 621.4

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THE PROSPECTS FOR NUCLEAR ENERGY OF THE REPUBLIC OF BANGLADESH IN CONNECTION WITH THE ANALYSIS OF SEISMIC HAZARD

Abstract. The purpose of this study is to assess the seismic condition of the site for NPP construction in the Republic of Bangladesh. Seismic effects depends on the level of earthquakes and the PGA (peak acceleration of the earth). The analysis of the seismic activity of the territory of the Republic for a period of 400 years. This gives an idea of external hazards for the future construction of nuclear power plants in connection with natural phenomena.

Keywords: nuclear energy, nuclear power station, seismic hazard.

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ПЕРСПЕКТИВЫ АТОМНОЙ ЭНЕРГЕТИКИ РЕСПУБЛИКИ БАНГЛАДЕШ В СВЕТЕ АНАЛИЗА ПАРАМЕТРОВ СЕЙСМИЧЕСКОЙ ОПАСНОСТИ

Аннотация. Целью настоящего исследования является оценка сейсмического состояния территории для строительства АЭС в Республике Бангладеш. Сейсмические эффекты зависят от уровня землетрясений и PGA (пиковое ускорение земли). Приводится анализ сейсмической активности территории Республики за период 400 лет. Это дает представление о внешних опасностях для будущего строительства АЭС в связи с природными явлениями.

Ключевые слова: атомная энергетика, ядерные энергетические станции, сейсмическая опасность.

Bangladesh is presently a mono energy country as far as power generation is concerned. About 87 % power is generated from gas, while coal contributes a meager 3 % of the total generation and the rest of sources are imported oil (6 %) and hydro (5 %) and furnace oil (5 %) [1]. Renewable generate electricity is amounting about 0.50 % of the total power generation. Now it is evident that the country's reserve of gas is fast depleting and if there was no new discovery of gas field, the present reserve is not sufficient to meet our upcoming demand.

The Perspective Plan and "Power System Master Plan 2010" has outlined the construction of 2000 MW (e) Nuclear Capacity by 2021 and 4000 MW (e) by 2030 [2].

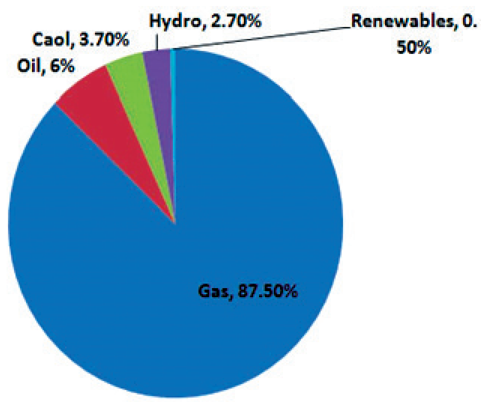

Fig. 1. Energy mix diagram in Bangladesh

Location: Ishwardi, Pabna
Eastern bank of Padma River
160 km north-west from Dhaka
Construction area 260 acres and total site area is about 1060 acres

Fig. 2. Over view map of selected NPP site in Bangladesh

Table 1

The perspective Energy plan outlined construction of NPP in Bangladesh

Sl. No.	Description	Capacity (MW)	%
1	Domestic Coal	11,250	51
2	Imported Coal	8,400	
3	Domestic Gas/LNG	8,850	23
4	Regional Grid	3,500	9
5	Nuclear Energy	4,000	10
6	Others (Oil, Hydro and renewable)	2,700	7
Total		**38,700**	

Information on earthquakes in and around Bangladesh is available for the last 250 years. It is seen that historically Bangladesh has been affected by five earthquake of large magnitude during the 61 year period from 1869 to 1930 [3].

Table 2

Previous information on Earthquake magnitude during the year (1664–1930)

Date	Name of earthquake	Magnitude (Richter)	Approximate Epicentral Distance from site (km)
1664	Bangla Earthquake	7.8	92
1869	Cachar Earthquake	7.5	290
1885	Bengal Earthquake	7.0	90
1897	Grate Indian Earthquake	8.7	242
1918	Srimangal Earthquake	7.6	270
1930	Dhubri Earthquake	7.1	237

The site proposed for the first nuclear power plant of Bangladesh lies on the eastern bank of the river Ganges, in the west-central zone of the country. It is situated in the village Rooppur (selected site), The frequency of earthquakes in the near-field region of the site is relatively low. Although most of the faults are geologically old and inactive in this part of Bangladesh, and seismically active faults of recent age are rare, the possibility of future earthquakes cannot be ruled out [4]. The magnitude of major earthquakes in and around Bangladesh [5].

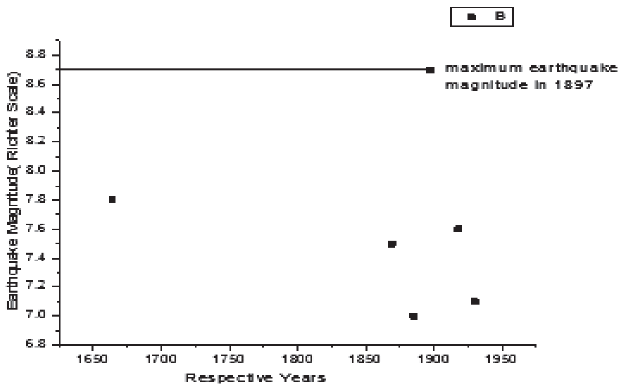

Fig. 3. Graph of Earthquake magnitude in respective years

Peak Ground Acceleration (PGA)

In our present study, the following Duggan's Equation (Beno Gutenberg and Charles Richter) [6] has been used to determine the Earthquake Magnitudes against the PGA values. The Duggan's Equation of motion is as follows:

$$Y = 227.3 \cdot 10^{0.308M} (d + 30)^{-1.201} \quad (1)$$

Where, Y = PGA (in cm/sec^2); d = Epicentral distance (in km); M = Earthquake magnitude (in Richter scale).

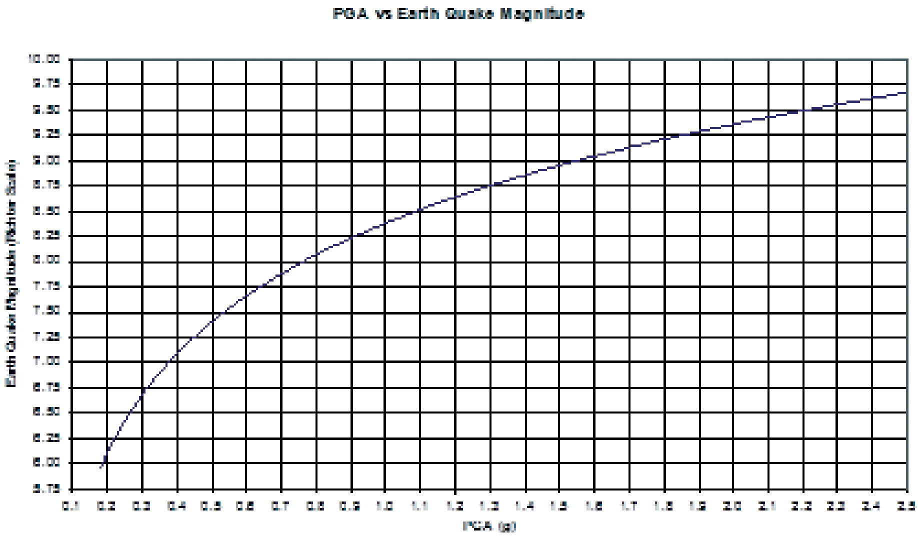

Fig. 4. Graph for Earthquake Magnitude (Richter scale) Versus PGA (g)

We can calculate it by the Equation relation between earthquake energy and earthquake magnitude, and earthquake energy & distance.

$$\mathrm{Log}_{10} E = 11.4 + 1.5M \tag{2}$$

Table 3

The estimated data of maximum possible earthquake level at respective selected site (Rooppur) due to Madhupur Fault (Aerial distance from selected site is 116 km)

Madhupur Fault (M)	Selected Site (M)
9	7.6
8.5	7.1
8	6.6
7.5	6.1
7	5.6

Maintaining a High Standard for Safety Issues

The main objective of Power System Master Plan 2010 is to mitigate the current demand of electricity in Bangladesh. The highest priority must be the safety issues and to maintain the international safety margins. The future prospect of nuclear energy in Bangladesh will depend on the proper site selection, design documentation and operation of countries first nuclear power plant. As Bangladesh is often havocked by earthquakes, it is very important to follow the safety rules and regulations for earthquake hazard on a first antecedence. The other natural events that may occur in the region must also be taken into account. It is mandatory to think about additional safety measures to be built into the facility so that it can withstand even stronger ground motion than pointed in the data. In order to achieve optimum safety the nuclear power plants are being planned must be designed and operated using “defense-in-depth” approach with multiple safety systems. It is compulsory to maintain high-quality design and construction. It is required to ensure safety equipment which prevents operational disturbances or human failures and errors developing into problems. Comprehensive monitoring and regular testing to detect equipment or operator failures must be ensured. It is a must to be aware of redundant and diverse systems to control damage to the fuel and prevent significant radioactive releases and provision to confine the effects of fuel damage to the plant itself.

Geotechnical parameters are considered as the critical parameters among other various site specific parameters for designing nuclear power plant for a particular nuclear power project site. The best way to determine those basis parameters is to establish correlation between seismic acceleration versus potential damages due to earthquake. It is very necessary to have over look to review some of the relationship among seismic acceleration and potential damage. Here It may be noted that the United States Geological Survey developed an instrumental intensity scale which maps peak ground acceleration and peak ground velocity on an intensity scale similar to the felt Mercury scale. These values are used to create shake maps by seismologists around the world. These values are shown in Table 4.

Table 4

Seismic acceleration versus potential damages

Instrumental Intensity	Acceleration (g)	Velocity (cm/s)	Perceived Shaking	Potential Damage
I	< 0.0017	< 0.1	Not Felt	None
II–III	0.0017–0.014	0.1–1.1	Weak	None
IV	0.014–0.039	1.1–3.4	Light	None
V	0.039–0.092	3.4–8.1	Moderate	Very light
VI	0.092–0.18	8.1–16	Strong	Light
VII	0.18–0.34	16–31	Very Strong	Moderate

Instrumental Intensity	Acceleration (g)	Velocity (cm/s)	Perceived Shaking	Potential Damage
VIII	0.34–0.65	31–60	Severe	Moderate to Heavy
IX	0.65–1.24	60–116	Violent	Heavy
X+	> 1.24	> 116	Extreme	Very Heavy

Our present study will emphasize to think and suggest to include nuclear reactor as additional device for increasing diversity in the energy sector in Bangladesh. Finally it shows that the perspective zone will have to capable to withstand the earthquake impact not more than 9 (Richter Scale) [7].The estimated data of the peak ground acceleration describes the suitability of the nuclear project. The design basis parameters are determined which help us in determining a suitable nuclear power technology appropriate for Bangladesh [8].

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